

# Mustard (Brassica Sp.) Seed Productivity : How to improve yield with existing technologies?

Presentation at SEA Annual Rapeseed-Mustard Conclave'2018  
at Jaipur, Rajasthan



## **VIJAY SARDANA**

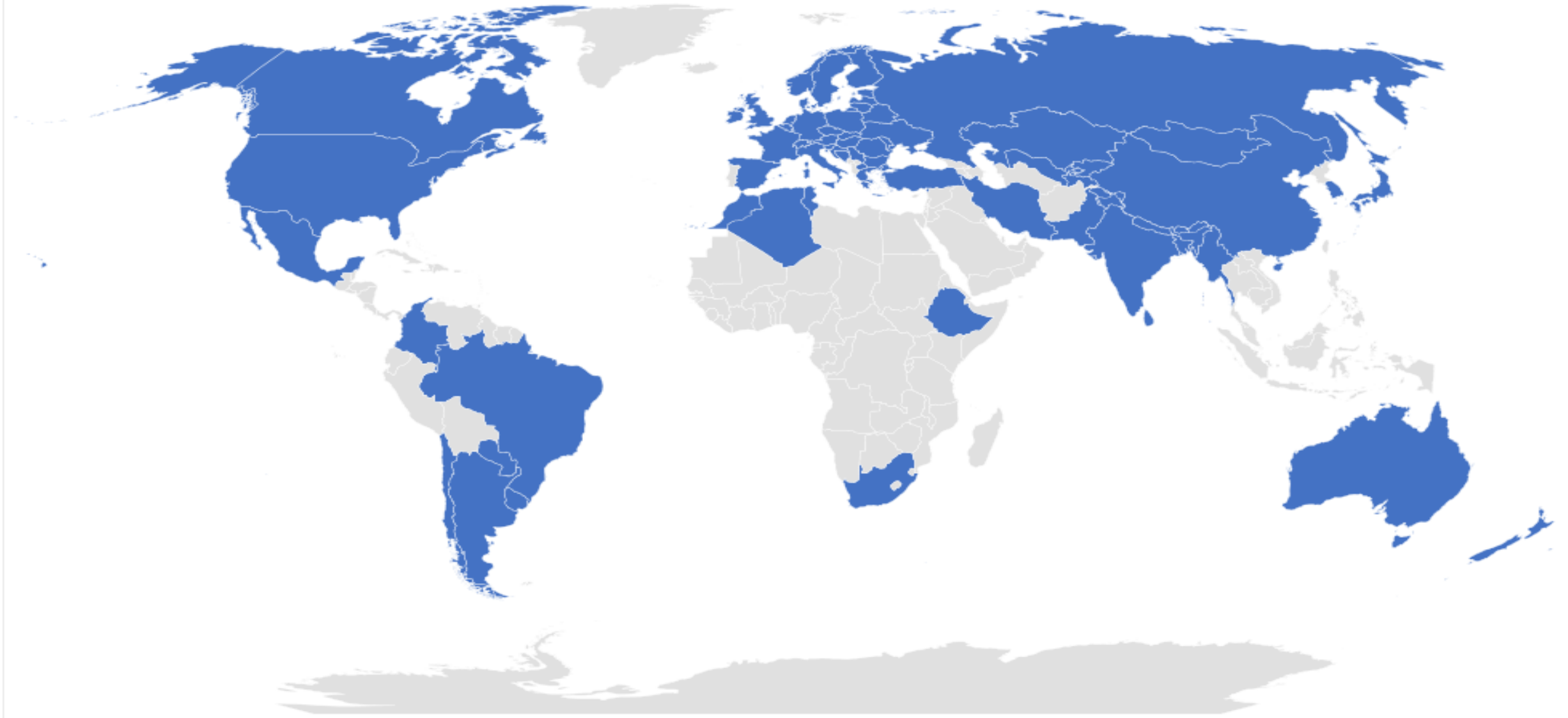
PGDM (IIM-A), M.Sc. (Food Tech.) (CFTRI), B.Sc. (Dairy Tech.), Justice (Harvard),  
PG (Trade Laws & ADR)(ILI), LL. B (in Progress),

**Specialized in Agribusinesses Value Chains & related Business Laws  
(Head – Food Security & Agribusiness, UPL Group)**

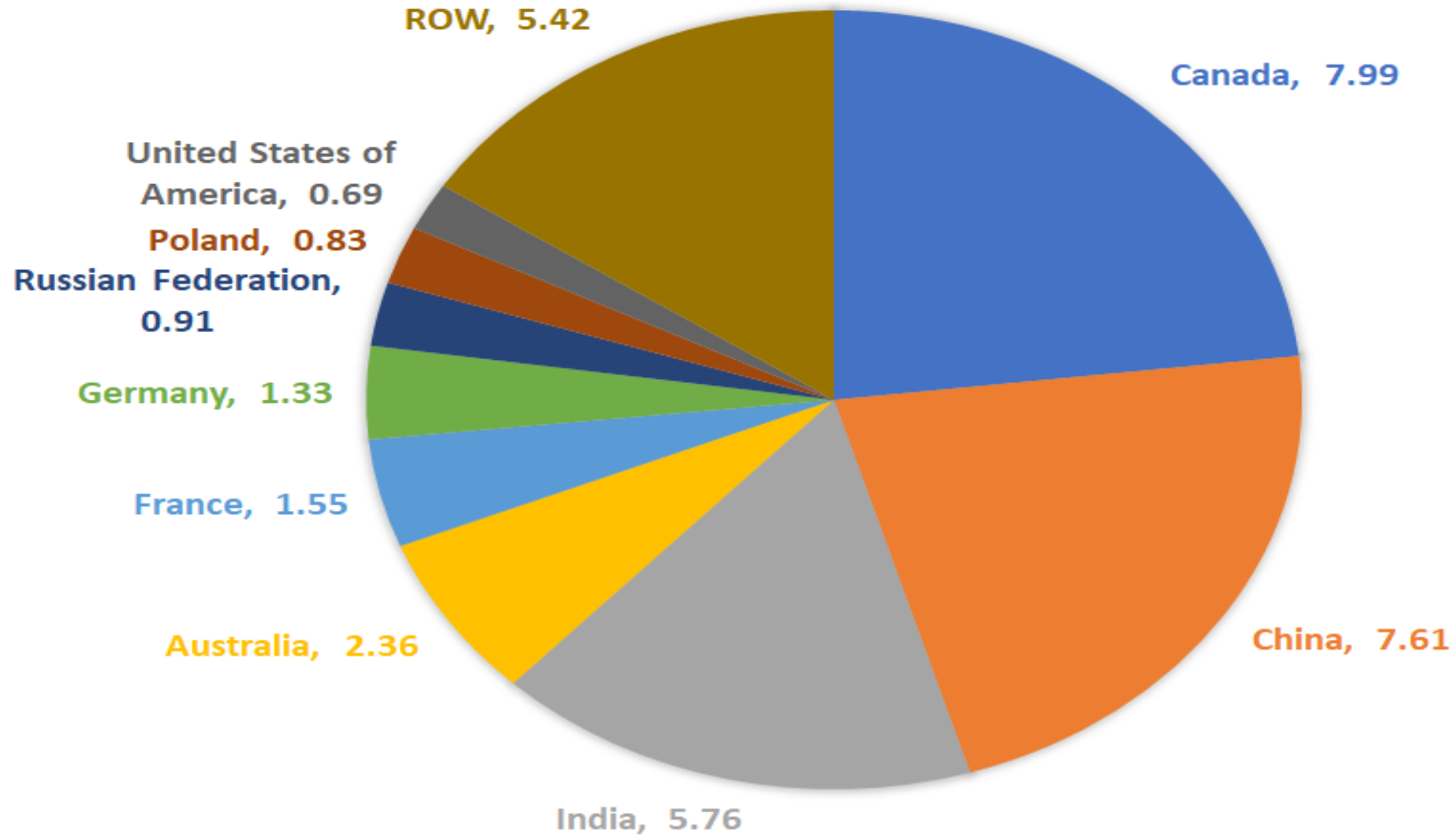
# Content of the Presentation

- 1. Current situation of RM seed globally and in India**
- 2. Challenges faced by Indian RM Seed sector**
- 3. What are possible interventions to change the current situation**
- 4. Possible outcomes of the interventions**

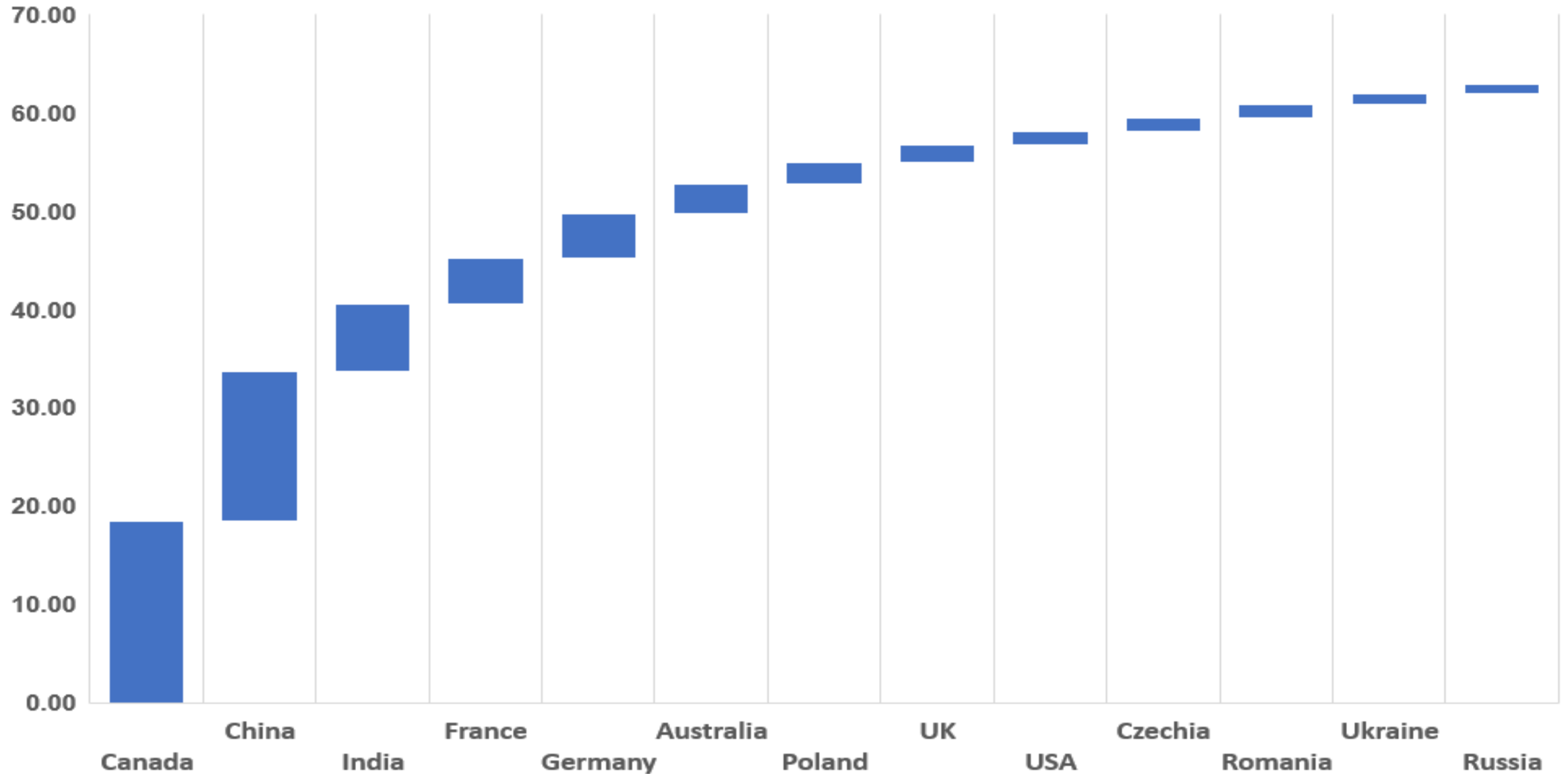
# Mustard and Rapeseed Production Areas



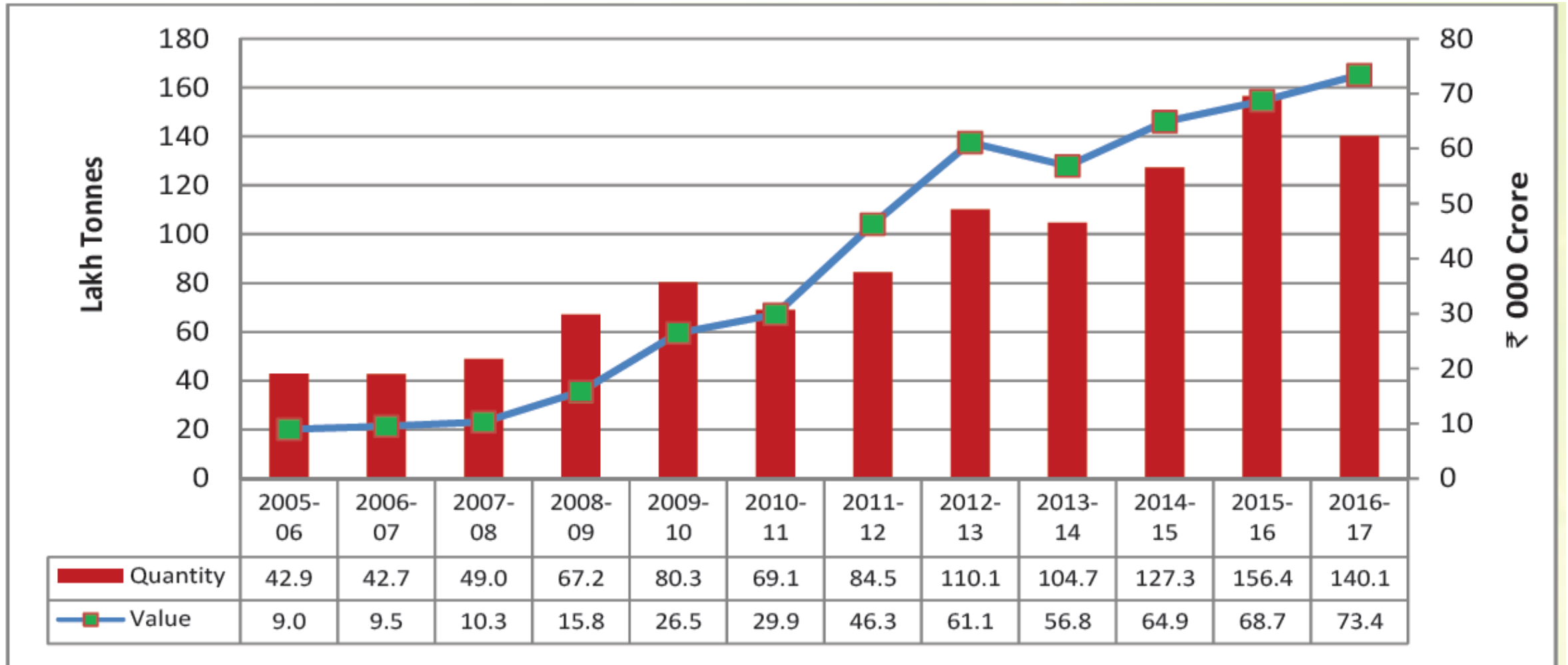
### PRODUCTION AREA (IN MILLION HECTARE)



Total Production (in Mio Tons)



# India's Import of edible oil



Source: Directorate General of Commercial Intelligence and Statistics

## **R&M Seeds:**

- Global production of R&M was 70.1 million tonnes, out of which 21.1 percent (14.8 million tonnes) was traded.
- EU is the largest producer of R&M with a share of 31.8 percent, followed by China (25.3 percent), Canada (20.5 percent) and India (8.5 percent).
- Canada is the largest exporter of R&M with a share of 66.8 percent, while China is the largest importer with a share of 27.6 percent, followed by EU (22.3 percent) and Japan (16.6 percent).

## **R&M Oil:**

- Global production of R&M oil was 27.8 million tonnes in TE2016-17, out of which about 15.1 percent was traded.
- EU is the largest producer of R&M oil (10.2 million tonnes) with a share of 36.9 percent followed by China (25.1 percent), Canada (13.1 percent) and India (6.8 percent).
- Canada is the largest exporter of R&M oil with a share of 65.6 percent, followed by EU (8.1 percent). China is the largest importer of R&M oil with a share of 17.6 percent, followed by India (9.7 percent) and EU (4.9 percent).



# Production & Yield in major RM Seed producing Countries

Country	Area (Lakh ha)			Production (Lakh tonnes)			Yield (Kg/ha)		
	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16
Canada	80.09	80.75	83.20	179.55	155.55	183.80	2242	1926	2210
China	75.20	65.51	73.00	144.58	116.00	143.00	1923	1771	1950
France	14.38	15.04	67.5*	43.70	55.23	245.90*	3039	3673	3640
Germany	14.66	13.95		57.84	62.47		3945	4479	
Poland	9.21	9.52		26.78	32.76		2907	3442	
UK	7.16	6.76		21.28	24.60		2974	3641	
<b>India*</b>	<b>66.50</b>	<b>57.90</b>		<b>57.62</b>	<b>78.80</b>		<b>63.10</b>	<b>68.22</b>	
Australia	32.72	27.22	23.60	41.42	38.32	29.90	1266	1408	1270
Russia	11.09	10.62	10.60	13.93	14.64	13.20	1256	1378	1250
Ukraine	9.97	8.66	8.80	23.52	21.98	22.00	2360	2538	2500
<b>WORLD</b>	<b>369.55</b>	<b>365.90</b>	<b>355.20</b>	<b>733.75</b>	<b>716.42</b>	<b>714.50</b>	<b>1986</b>	<b>1958</b>	<b>2010</b>

\*Pertains to European Union ; \*\*As per the estimates of DES, DAC&FW

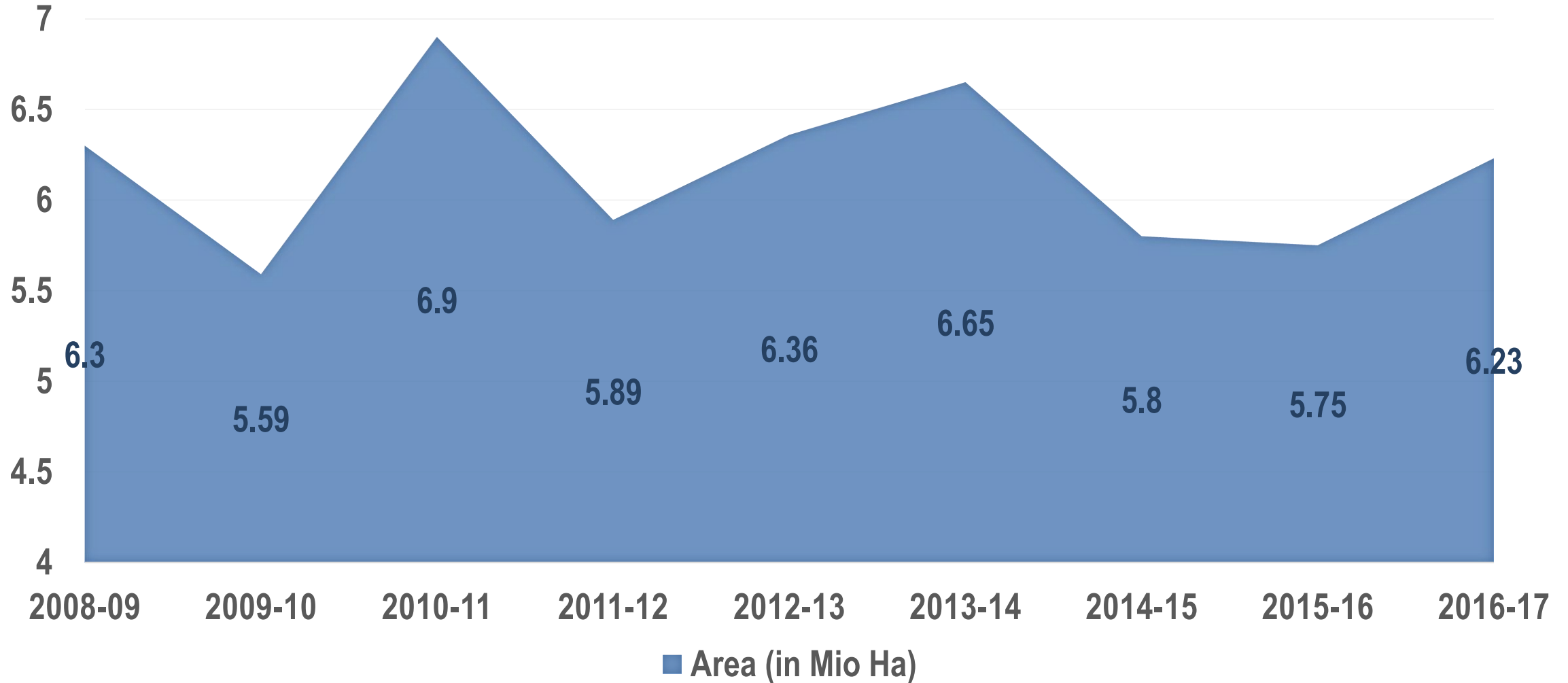


## Major States producing RM Seeds

States	Area (Lakh ha)			Production (Lakh tonnes)			Yield (Kg/ha)		
	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16
Rajasthan	30.79	24.74	25.49	37.97	28.95	32.69	1233	1170	1282
Haryana	5.37	4.96	5.05	8.80	7.00	8.05	1639	1409	1594
MP	7.62	7.13	6.17	8.44	7.17	7.00	1108	1006	1134
UP	6.62	6.26	5.93	7.37	5.82	6.02	1113	930	1015
WB	4.49	4.52	4.58	4.78	4.90	4.99	1066	1084	1090

# Area under R&M Seeds remain Stagnant

AREA (IN MIO HA)

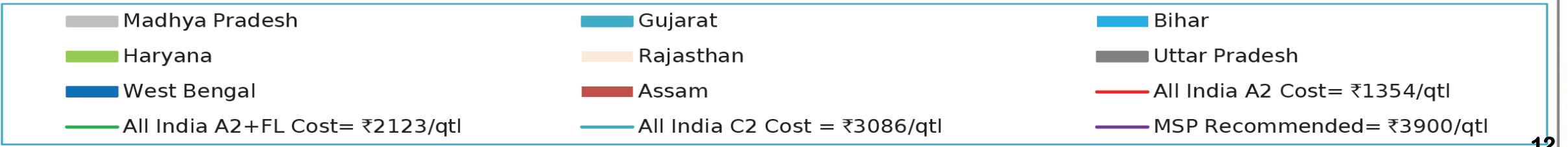
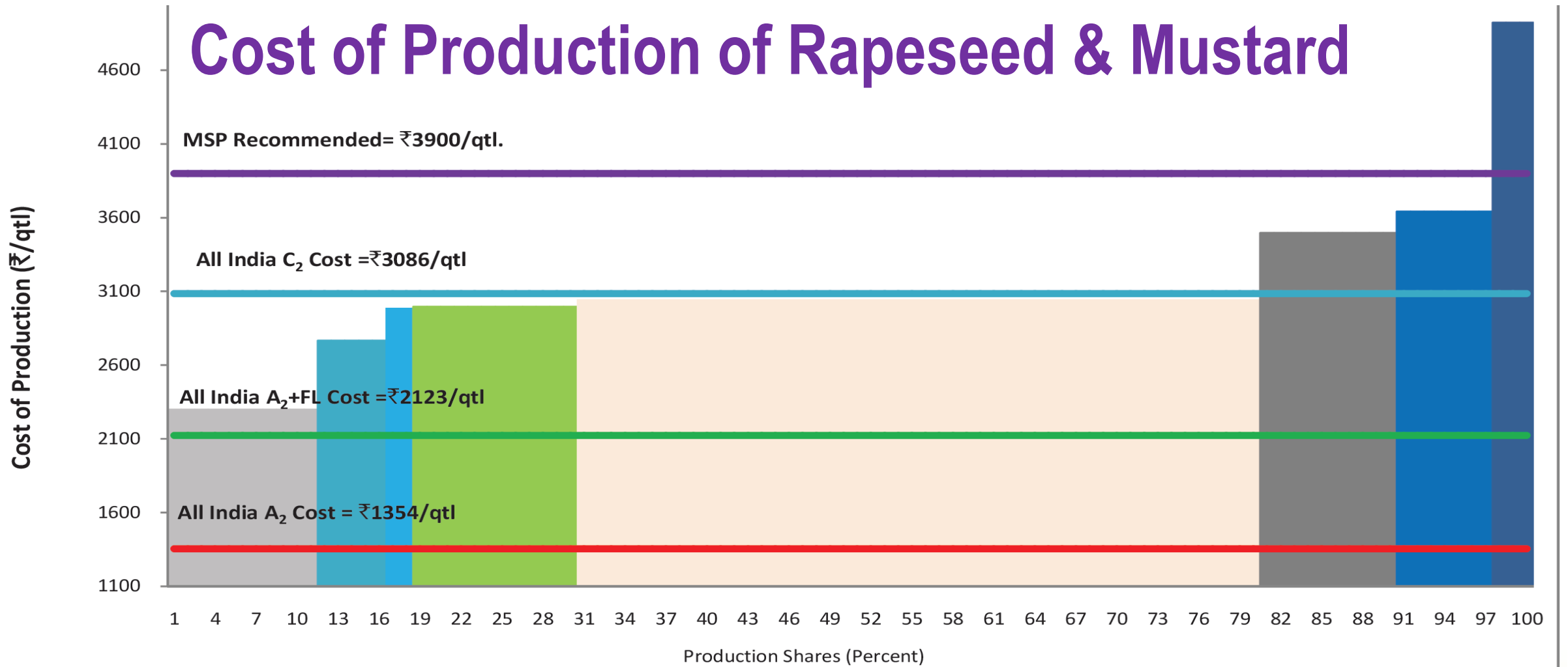


# Crop-wise Relative Returns (Percent)

Crops	Relative Gross Returns over $A_2$ with respect to wheat	Relative Gross Returns over $A_2+FL$ with respect to wheat	Relative Net Returns with respect to wheat
<b>A. Cereals</b>			
Wheat	100	100	100
Barley	104	88	101
<b>B. Pulses</b>			
Gram	56	53	43
Lentil	64	65	67
<b>C. Oilseeds</b>			
Rapeseed & Mustard	85	74	74
Safflower	9	-4	-54

Source: CACP Calculations.

# Cost of Production of Rapeseed & Mustard



# Good Agriculture Practices (GAP) and its impact on Productivity of RM Seed

<b>Technological components</b>	<b>Increase in productivity (%)</b>
Improved varieties	9-45
Plant protection measures	7-24
Recommended fertilizers	16-18
Sulphur nutrient	9-16
Thinning to remove excess plants/sqm	13-16
Thiourea spray at flowering	10-12
Timely weeding	11-27
Chemical weed control	14-35

# Yield Gap in existing Varieties in States

State	Mustard			
	Rabi 2013-14 (Irrigated)			
	SAY	FLD	Yield Gap (%)	Varieties
Gujarat	1723	2499	45	GDM-4
Haryana	1639	2264	38	RH-0749, R-8812
MP	1108	1472	33	RVM-2
Rajasthan	1233	1907	55	NRCDR-2, NRCHB-101, RGN-73, RGN-229, RGN-236
UP	1113	1943	75	NRCDR-2, NRCHB-101
West Bengal	1066	1261	18	Pitambari
<b>All India</b>	<b>1314</b>	<b>1891</b>	<b>44</b>	



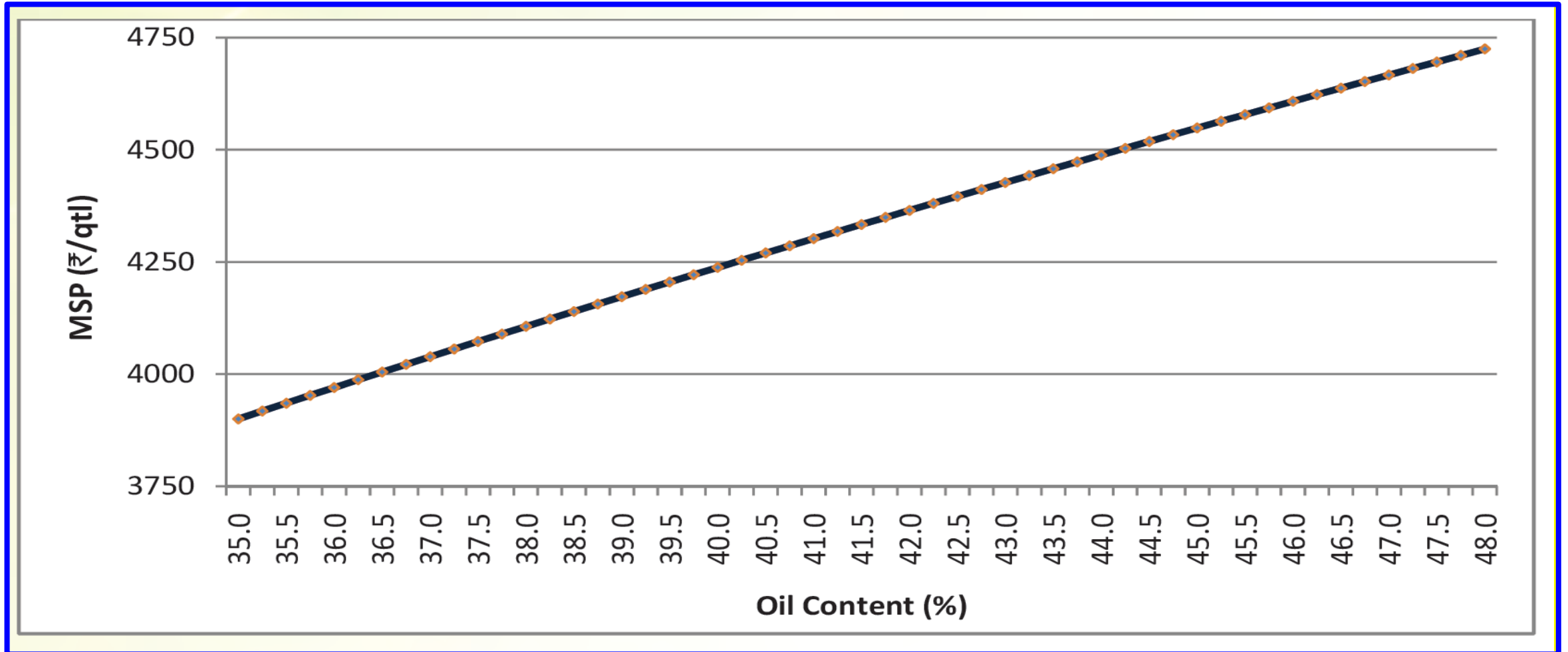
# Seed Replacement Rate in RM Crop

<b>Year</b>	<b>Area sown (lakh ha)</b>	<b>Total seed required (lakh qtls.)</b>	<b>Seed supplied (lakh qtls.)</b>	<b>SSR (%)</b>
2012-13	63.60	3.18	1.88	59
2013-14	66.50	3.32	1.63	49
2014-15	57.90	2.89	2.13	74

# Fatty Acids and their Nutritional Significance

Fatty Acids		Nutritional Significance
Palmitic Acid	16:0	According to the World Health Organization (WHO), palmitic acid raises these LDL levels more than other saturated fats, like stearic acid. They say there is convincing evidence that high consumption of palmitic acid can increase the risk of <b>cardiovascular disease</b>
Stearic Acid	18:0	It is used as ingredient in making candles, soaps, plastics, oil pastels, lubricant, cosmetics and as a softener in chewing gum base and for suppositories.
Oleic Acid	18:1	Can help reduce your risk of heart disease by raising your levels of high-density lipoprotein, the "good" cholesterol. They're also beneficial because they can also lower your low-density lipoprotein, the "bad" cholesterol.
Linoleic Acid	18:2	It can cause cholesterol levels to drop, which can reduce the risk of heart disease
Alfa-Linoleic Acid	18:3	Alpha-linolenic acid is popular for preventing and treating diseases of the heart and blood vessels. It is used to prevent heart attacks, lower high blood pressure, lower cholesterol, and reverse "hardening of the blood vessels" (atherosclerosis).
Erucic Acid	22:1	Studies done on laboratory animals in the early 1970s show that erucic acid appears to have toxic effects on the <b>heart</b> at high enough doses. An association between the consumption of rapeseed oil and increased myocardial lipidosis, or <b>heart disease</b> , has not been established for humans.

# MSP based on Oil Content of R&M



MSP will increase by **Rs.15.83/qtl** for every **0.25 percent** point increase in oil content above the base oil content of 35 percent in R&M seed

Species	Accession	Oil content (%)	Fatty acid composition in the oil (%)						Total <sup>a</sup>
			C16:0	C18:0	C18:1	C18:2	C18:3	C22:1	
<i>B. napus</i>	B.N-4	38.7	<u>5.12</u>	<u>2.67</u>	<u>57.85</u>	18.41	8.42	3.30	95.77
	B.N-6	44.7	4.15	2.27	63.02	15.71	<u>4.87</u>	<u>0</u>	90.12
	B.N-7	<u>56.2</u>	4.31	2.14	<u>64.63</u>	17.67	7.25	<u>0</u>	<u>96.10</u>
<i>B. juncea</i>	B.J.J-13	24.7	4.07	1.34	13.98	20.66	21.31	29.20	90.59
	B.J-16	31.8	3.28	1.18	12.46	17.46	18.35	38.19	90.92
	B.J-I-17	26	2.75	1.07	13.35	17.76	18.45	37.90	91.39
	B.J.J-36	20.4	4.29	1.76	16.69	22.39	<u>22.80</u>	23.75	91.65
<i>B. carinata</i>	B.C.B-18	25.1	2.85	0.84	<u>8.42</u>	15.03	18.20	45.23	90.57
	B.C.B-19	29.1	3.54	1.01	10.69	18.03	18.53	38.89	90.70
	B.C.B-22	26.4	3.10	0.95	10.42	<u>18.86</u>	18.20	39.64	91.17
<i>B. oleracea</i>	B.O.G-44	29.2	3.61	<u>0.79</u>	14.58	13.30	14.76	46.38	93.43
	B.O.A-45	26.6	<u>2.17</u>	1.01	17.81	11.44	15.82	46.26	94.51
	B.O.C-52	28.7	<u>4.13</u>	0.70	14.21	12.46	14.82	46.25	92.57
<i>B. nigra</i>	B.N.N-28	<u>17.9</u>	4.19	1.51	14.05	15.99	17.66	35.50	<u>88.90</u>
	B.N.N-29	24.6	3.08	1.42	12.47	18.38	20.03	34.76	90.16
<i>B. rapa</i>	B.R.D-10	41	2.89	1.84	22.22	14.55	16.09	34.70	92.31
	B.R.C-32	22.8	3.92	1.80	26.72	17.69	17.74	24.89	92.75
	B.R.C-35	23.4	2.55	1.18	13.78	12.72	14.95	46.33	91.51
	B.R.P-61	33.5	2.31	1.20	15.54	11.51	15.88	47.58	94.02
	B.R.P-64	38.8	2.23	1.22	15.20	<u>11.25</u>	15.75	<u>48.15</u>	93.83

# Points for consideration to increase Oil Yield

- The considerable genetic variation and high heritability for oil content and fatty acid composition suggested that selection for improving oil content and some of the fatty acid composition might be promising.
- The findings indicated that wild species exhibited significantly lower average oil content than the cultivated rapeseed. Nevertheless, these species may be a good source of genes to improve some fatty acid composition or other traits of rapeseed.
- Among wild species, *B. rapa* and *B. oleracea* had the highest oil content and high erucic acid that can be used for industrial applications.
- **Furthermore these species are easily crossed to cultivated rapeseed and can be used as a new source of biotic and abiotic stress resistance genes or for incorporating in genetic studies such as re-synthesis *B. napus*. The results of genotypic and phenotypic correlation were in line with the biosynthetic pathways of the major fatty acids.**

# How to select right variety?

- High oil content in *Brassica* serves as the most important breeding objective.
- Oil content was positively and significantly correlated to oleic and stearic acids.
- Strong significant and negative correlations were found between oil content with linolenic and erucic acids.



# What should be our research priority?

- The presence of strong and negative correlations between oleic and erucic acids denoted that those genes which contribute to high erucic acid content, **function at the expense of desaturation to linoleic and linolenic acids.**
- Two separate biosynthetic pathways which are genetically independent are responsible for this result, one which converts oleic acid to linoleic and the other which converts **oleic to eicosenoic to erucic acid.**
- Large increases in oleic acid content, due to the genetic absence of erucic acid, did not lead to sharp increases in linoleic acid.
- The palmitic acid also correlated negatively to linolenic and erucic acids. These results are in line with the biosynthetic pathway of the main fatty acids from oleic acid as many authors pointed out that **erucic acid is formed from oleic acid via chain lengthening process and linoleic and linolenic acids are formed by successive desaturation of oleic acid.**

# Transgenic Approaches for Mustard - Rapeseed

Transgenic approaches have been followed to develop the transgenic for:

- Aphid resistance
- Male sterility
- AB Tolerance
- Herbicide resistance
- Drought tolerance.
- **What will be the impact of all these options on yield drag and consumer quality need detailed investigation. If available, user industry must study this before adopting.**
- If required, We may need different approach for genetic research to meet our edible oil requirements.

# What is the way forward for better RM Seed Productivity?

S. No.	Action required	Expected Benefit	Cost implication
1	Identify soil deficiencies & recommend suitable nutrients	Additional 15%	Product cost, but will be recovered due to extra production
2	Timely control of weeds	Additional 10%	Product cost, but will be recovered due to extra production
3.	Proper and timely plant protection activities	Additional 10%	Product cost, but will be recovered due to extra production
4.	Seed replacement based on agro-climatic and soil conditions	Additional 20% to 50% (Average)	Product cost, but will be recovered due to extra production
	<b>Target is</b> : 50 to 60% increase in output	<b>Additional gain</b> : 55% to 75%	<b>Target can be achieved in 2 to 3 years time.</b>

# What is the way forward for better RM Seed Productivity?

- 1. Promote Good Agriculture Practices** - This will give additional 50% to 70% yield
- 2. Look for suitable varieties with minimum erucic acid for oil rich crop** depending upon the needs of the market and industry. These can be:
  - **“0” varieties (with pungency & Without Erucic Acid) and**
  - **“00” varieties (Without Pungency and Without Erucic Acid) (Example Hyola/Canola)**

**This combination will increase Mustard Oil production by 80 to 100%.**

## Outcome of the Recommendations for Productivity Enhancement

Total area under rapeseed-mustard	Ranges between 5.59 to 6.9 mio ha.
Existing average yield:	Ranges between 1080 to 1180 kg./ha.
Oilseed production with existing seeds	<b>Ranges between 6.03 to 8.14 mio tons</b>
Oil extraction @ 36%	<b>Range 2 mio tons to 3 mio tons</b>
<b>After proposed Interventions:</b>	
Projected yield by GAP (50 to 70%)	<b>Average Projected yield = 1650</b>
Oil production with low erucic acid seeds	From 38% to 44% = 6% jump in oil yield
Projected RM seed production production	<b>Est. 11 to 12 million tons</b>
Average oil production @42%	<b>Est. 4.60 to 5.25 million tons</b>
MSP will be improve	<b>From Rs. 39 to 44 per kg</b>

# Implications of the Proposed Intervention

Existing gross income per hectare	In the range of Rs. 39000 - 46000
Income after proposed interventions	In the range of Rs. 70000 - 72000
Existing RM Seed production	In the range of 6 to 8 million tons
Proposed RM seed production	In the range of 11 to 12 million tons
Existing RM Oil Production	In the range of 2 to 3 million tons
Proposed RM Oil Production	In the range of 4.5 to 5.25 million tons
Existing Oil Cake production	In the range of 4 to 5 million tons
Proposed Oilseed Production	In the range of 6.5 to 7 million tons



# What should be done?

- **Mustard mission should be developed in line with Castor Mission of SEA members and supported by policy makers.**
- **Mustard Industry should develop action plan with farmer groups, FPOs, seed companies, agriculture input companies. Research institute and government agencies must the initiative in time bound manner.**
- **Mustard seed economy at input cost level) from USD 3.5 to 4.5 billion to USD 7.4 to 8.1 billion. Can't we spend 1% of the proposed gain every year on extension and model farms development to achieve the stated objective.**

**Time to think seriously.**

# Open for Discussion...



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